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# Oral health of seafarers — a review

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## ABSTRACT

**Background.** Poor oral health of seafarers is known to cause pain and suffering for individuals and logistical complications for shipping companies during voyages. The aim of the study was to discuss the oral health of seafarers against the backdrop of available publications.

**Material and methods.** A systematic review of all literature listed in PubMed up to August 2010 plus a hand search analysing origin of article, target group, data presented, and recommendations given. Excluded were papers on forensic dental identification and papers on mercy ships.

**Results.** Most articles deal with oral health issues in the military, are published in English, and originate from the US or Great Britain. Screening systems, organisation of dental services, and the provision of dental treatment ashore and aboard are dominant themes. Papers dealing with the merchant navy, fishing vessels, and cruise ships crews mostly present basic epidemiological data, focus on oral health at sea, and originate from industrialised countries. The growing numbers of cruise ship passengers is the subject of seven studies. Generally, dental care offered to navy crews appears more comprehensive than that offered to civilian crews.

**Conclusions.** The research base needs to be expanded to cover all seafarers. Dental professional expertise should be sought in policy and guideline development relevant to oral health. A strategy comprising preventive, screening, and treatment service components should be developed and a certificate of dental health introduced. Funding strategies in a complex environment of transnational stakeholders for the improvement of oral-health services for seafarers are needed. Aspects of military oral health care systems could be an example for civilian operators.

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**Key words:** oral health, maritime dentistry, seafarers, prevention, screening

## INTRODUCTION

The working conditions of seafarers vary widely. While on typical merchant marine cargo vessels they are characterised by small crews covering long distances with rather monotonous watches over extended periods of time at sea alternating with short busy periods in port, on military vessels large crews operate in a wide variety of changing conditions in exercises and combat during comparatively shorter sea times alternating with more frequent and longer logistical and maintenance periods in port.

Within the merchant fleet, cruise vessels frequently carry even larger numbers of crew, most of which are employed in the hotel department, and offer vastly different working conditions more resembling work in luxury hotels ashore than work on cargo vessels. They typically spend nights at sea and enter ports only for the daytime period. Yet another differing and specific working environment is found within the fishing fleets, where the smaller units are frequently operated by owner-captains with small crews in the adverse conditions of the high seas

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with much work performed on the open deck exposed to the elements.

Working conditions are but one factor affecting oral health. Another source of variation is from the seafarers themselves, stemming from industrialised or developing countries with differing health-care systems, differing socio-economic and cultural backgrounds, and differing educational standards and nutritional habits, which are all factors potentially influencing oral health.

Yet there are common threads: 24-hour operations require working in watches. On all types of vessels this influences nutritional patterns, with frequent snacking [27, 40] and consumption of caffeine as stimulants particularly during the night. The ensuing regular intake of fermentable carbohydrates during the watch is known as a prime risk factor for dental caries. Nicotine, widely used as a stimulant and for stress relief among seafarers [23, 51], is the most relevant preventable risk factor for periodontal disease. Long working hours encourage unhealthy lifestyles, lack of physical exercise, and social isolation with oral health becoming a low priority. With the exception of some naval dental services, the availability of professional oral healthcare for seafarers is limited to times ashore.

Another rather different group of people going to sea are cruise ship passengers. Their numbers have steadily increased with ever-larger vessels carrying 6000 or more passengers plus crew. Even though the vast majority of cruises offered do not exceed one week, with frequent stops in port where dental services can be provided, a growing minority of cruise ships offer round-the-world voyages of much longer duration. Here specific concerns relating to oral health have been raised.

Against the backdrop of the numerous sources of variation, it was the aim of this study to assess all available literature on oral health for seafarers, extract universal trends, and to make general recommendations as well as offer advice for specific subgroups.

## MATERIAL AND METHODS

### DATA SOURCES AND STUDY SELECTION

The literature search aimed to obtain the widest possible overview of all international literature on oral health at sea listed in PubMed. The search terms employed were either dental or oral combined with one of the following: maritime medicine, cruise medicine, ship, seafarers, fisherman, navy, sea, or crew and yielded 1724 titles as of August 2010. In a scree-

ning process titles relevant for the oral health of seafarers or cruise passengers including aspects of organising oral health services, epidemiology, and technical matters ashore and aboard were identified. The subsequent review of the abstracts revealed ten articles on dental forensic identification in accidents at sea and a further 19 reports of the operation of dental services on mercy ships. These were excluded from analysis. A search of the Internet and of the Library of the Head Clinics of Leipzig University produced seven additional articles that were included. For the total of 90 articles full text copies were ordered of which 80 were obtainable. A further review of full texts led to the exclusion, for lack of relevance to oral health at sea, of six articles. The final number of relevant articles included in the analysis was 74 from the period 1951–2008 [1–74]. Three further papers identified during the review of the manuscript [75–77] were incorporated in the discussion. Studies were classified in accordance with the levels of evidence as published by the Oxford Centre for Evidence Based Medicine [78]. From these articles the following data were extracted in a systematic manner and entered into SPSS (Ver. 12.0, SPSS Inc., 233 S. Wacker Drive, Chicago, IL 60606): year, civilian or military author, national origin, type of article, focus on sea or shore, provision of dental treatment, epidemiological data, and recommendations given and for civilian articles only: section of industry, focus on crew or passengers.

## RESULTS

From the publications analysed, 43 articles published since 1951 could be classified as original articles, more than half of which came from three countries, Germany, the UK, and the USA. The classification of papers as original, journalistic, short communication, etc. by author's country of origin is presented in Table 1. Fifty-two (70.3%) papers were published in English language. Whereas the setting of the majority of papers originating from the US and Britain was military, German publications were mainly written by civilian authors, accounting for one third of all civilian publications identified. The industrialised countries of the north dominate the setting by geographical origin, with details presented in Table 2. General epidemiological data were published by 38 (53.5%) authors, specific figures on caries incidence by 26 (36.6%), and periodontal conditions by 20 (28.2%) papers. Four papers, one military [40] and three civilian [35, 58, 63], considered cost issues. Most recommendations, given in 21 (28.4%) papers

**Table 1.** Number of articles by type and author's country of origin

Author's origin	Type n (% within type)			Personal/ /Journalistic	Historic/ /Book/Other	Total n (%)
	Original	Review	Short			
UK	9 (20.9)	0 (0)	1 (7.7)	1 (16.7)	2 (18.2)	13 (17.6)
Germany	9 (20.9)	0 (0)	0 (0)	3 (50)	1 (9.1)	13 (17.6)
USA	8 (18.6)	0 (0)	6 (46.2)	1 (16.7)	5 (45.5)	20 (27.0)
Norway	5 (11.6)	0 (0)	0 (0)	0 (0)	0 (0)	5 (6.8)
Finland	3 (7.0)	0 (0)	0 (0)	0 (0)	0 (0)	3 (4.1)
Poland	3 (7.0)	1 (100)	0 (0)	0 (0)	0 (0)	5 (5.4)
Bulgaria	2 (4.7)	0 (0)	0 (0)	0 (0)	0 (0)	2 (2.7)
Russia	1 (2.3)	0 (0)	6 (46.2)	0 (0)	2 (18.2)	9 (12.2)
India	1 (2.3)	0 (0)	0 (0)	0 (0)	0 (0)	1 (1.4)
Australia	1 (2.3)	0 (0)	0 (0)	0 (0)	0 (0)	1 (1.4)
RSA	1 (2.3)	0 (0)	0 (0)	0 (0)	0 (0)	1 (1.4)
France	0 (0)	0 (0)	0 (0)	0 (0)	1 (9.1)	1 (1.4)
Canada	0 (0)	0 (0)	0 (0)	1 (16.7)	0 (0)	1 (1.4)
Total	43 (100)	1 (100)	13 (100)	6 (100)	11 (100)	74 (100)

**Table 2.** Setting (military or civilian) by author's country of origin

Author's origin	Setting n (% within setting)		Total n (%)
	Military	Civilian	
USA	18 (43.9)	2 (6.1)	20 (27.0)
UK	11 (26.8)	2 (6.1)	13 (17.6)
Germany	2 (4.9)	11 (33.3)	13 (17.6)
Russia	7 (17.1)	2 (6.1)	9 (12.2)
Norway	0 (0)	5 (15.2)	5 (6.8)
Poland	0 (0)	4 (12.1)	4 (5.4)
Finland	0 (0)	3 (9.1)	3 (4.1)
Australia	1 (2.4)	0 (0)	1 (1.4)
Bulgaria	0 (0)	2 (6.1)	2 (2.7)
Canada	0 (0)	1 (3)	1 (1.4)
France	1 (2.6)	0 (0)	1 (1.4)
RSA	0 (0)	1 (3)	1 (1.4)
Total	41 (100)	33 (100)	74 (100)

[4, 5, 16, 17, 19, 20, 23, 25, 27, 37, 42, 50–52, 54, 58, 62, 63, 69, 71, 72], concerned dental screening, followed by 18 (24.3%) papers with technical recommendations [2, 4, 5, 7, 22, 27, 29, 31, 38, 40, 42, 52,

54, 56, 70, 72, 74], and preventive educational measures for crews in 13 (17.6%) articles [3, 23, 27, 28, 40, 46, 51, 52, 55, 62, 63, 66, 72]. Further recommendations included ships' officers training in five (6.8%) papers [9, 44, 51, 62, 67], ships' doctors training [4, 52, 56], and ships' dentists training [52, 56]. Six papers (8.1%) [13, 18, 35, 40, 49, 55] mentioned the importance of nutrition for oral health.

### MILITARY SECTOR

Forty-one papers (55%) dealt with military oral health: 14 at sea [2–5, 7, 18, 19, 22, 29, 31, 33, 38, 40, 74], 18 ashore [6, 10–12, 20, 30, 32, 36, 41, 43, 47, 48, 53, 55, 60, 68–69, 73], and 9 both at sea and ashore [9, 13, 21, 26, 46, 54, 56, 61, 66]. The dental services of the UK and USA navies generated more than 70% of all military papers (Table 2). The provision of dental treatment aboard was the subject of 8 (19.5%) articles [7, 9, 13, 19, 22, 29, 40, 61]. Seven descriptive studies were identified that used current health indicators when reporting incidences of disease in military personnel [11, 12, 19, 40, 47, 54, 55].

### CIVILIAN SECTOR

Thirty-three publications concerned civilian oral health: 25 at sea [14–17, 23, 28, 34, 35, 37, 42, 44, 45, 49–50, 52, 57–59, 62–65, 70–72], seven ashore [1, 24, 25, 27, 39, 51, 67], and one paper [8] both

ashore and at sea. By sector, issues of the cargo shipping industry dominated in 14 (42.4%) papers [24, 27, 28, 35, 37, 39, 44, 49–51, 62, 63, 65, 67], eight (24.2%) articles dealt with cruise ship dentistry [14–17, 57–59, 70], five (15.2%) had an overall approach [1, 8, 34, 42, 64], the fishing industry was represented in four (12.1%) publications [23, 52, 71, 72], and two (6.1%) papers [25, 45] concerned the oral health of offshore workers. The provision of dental treatment aboard was the subject of 13 (39.4%) of the civilian articles [8, 23, 24, 35, 52, 57–59, 63, 65, 70–72]. Seven authors, almost exclusively originating from the cruise ship industry [14–17, 57–59], reported epidemiological data which were presented with adequate statistical analysis and one reported on maritime health emergencies [42].

## DISCUSSION

### QUALITY, SETTING, AND ORIGIN OF PUBLICATIONS

The number of original articles is low considering the time span of 59 years and it is obvious that publications are highly skewed towards the industrialised countries of the north whereas important seafaring nations from the developing world are not represented in the scientific literature. Older publications with an epidemiological focus do not utilise current health indicators and are thus difficult to interpret. Controlled interventional studies are absent. Accordingly, most publications other than the descriptive studies have to be classified as “expert opinion” or level 5 evidence.

Modern dentistry has historical links to military naval health services. The author of the first textbook of modern dentistry, “Le Chirurgien Dentiste” (1723), Pierre Fauchard (1678–1761), joined the French royal navy at the age of 15 under the tutelage of a naval surgeon, an expert in the diseases of “dental organs” [68]. A dedicated naval dental service developed alongside dentistry, with the US navy employing a first dental officer as early as 1873 [21]. With the extensive resources available to military dental services it is thus not surprising to find a high proportion of papers on oral health at sea with a naval background. By comparison, the oral health of the vast numbers of civilian seafarers was underrepresented in the literature. However, specialised military systems of oral health care can be studied in an attempt to adapt lessons learnt for civilian use.

The search for publications on maritime oral health within PubMed has an inherent tendency to favour English language articles. Thus a skewed picture of the international literature is likely to be the basis of

this review. However, English is the operating language of the maritime industry, and it can be assumed that authors aiming at an international readership would prefer this language. Nevertheless, every effort was made to include as many Russian, German, and French studies as could be located, and no studies were excluded due to language concerns.

To adjust for regional and sectoral imbalances and to improve the quality and quantity of data on oral health of seafarers, broad efforts directed at all sectors of the maritime industry are needed to intensify civilian research, with particular emphasis to include less developed countries.

### PREVENTION

Oral hygiene aboard during long voyages has been described as being “totally neglected” [9] and self reported tooth-brushing habits were less frequent than ashore [40]. As early as 1965 Ugulava [66] suggested possible educational preventive measures, listing brochures and flyers, articles in seafarers’ publications, show-models explaining periodontal disease, and show cases with educational material ashore. Today electronic media could be added to this list. However, Wianz [72] doubted the effectiveness of printed information material ashore and his emphasis on interventions at the workplace is probably still valid today. The importance of nutritional advice has been highlighted by Mausberg [40], who reported the consumption of 2,400 kg of sweets on one vessel with 202 crewmembers during a four-month voyage. Healthy alternatives to sweets high in fermentable carbohydrates need to be available in ships’ crew shops. Any educational measures of primary prevention have to take the multitude of cultural backgrounds of crews aboard modern vessels into account. Drinking-water fluoridation as an established method of primary prevention ashore has been propagated for ships as well [3, 18]; however, there are no reports on implementation and efficacy aboard. The regular supply of fluoride on an individual level through the daily use of fluoridated toothpaste [46] is an accepted preventive measure and could be implemented without technical modifications to the ships water supply. All measures should be components of a national oral disease prevention program for seafarers [75].

### DENTAL SCREENING

Even though the number of seagoing dentists is very small, more than half of the papers focused on oral health at sea rather than ashore (Table 3). Within the civilian sector, where dental officers aboard

**Table 3.** Articles focussing on issues of oral health at sea or ashore by setting (military or civilian)

Setting	Oral health n (%)			Total
	At sea	Ashore	Both	
Military	14 (35.9)	18 (72.0)	9 (90)	41 (55.4)
Civilian	25 (64.1)	7 (28.0)	1 (10)	33 (44.6)
Total	39 (100)	25 (100)	10 (100)	74 (100)

are rare, two-thirds of the publications were focused on at sea conditions. It is laudable that dentists raise the issue of routine and emergency dental care aboard. However, with no regular professional dental services aboard merchant vessels, an approach focussing research on prevention and shore-based oral-health services may be more beneficial for the patients and possibly more cost effective as well.

Half of the military publications deal with oral health issues ashore. The emphasis of these military naval dental papers is firmly on prevention of emergencies occurring at sea, which, in the absence of professional dental help, cause suffering to the individual and may impede the mission of the ship. The method applied is a screening system leading to a systematic classification of dental conditions and targeted treatment. The recommendation for dental screening was the single most frequent recommendation given. An example of a widely utilised simple screening system is that of NATO, which comprises four classes: class I is dentally fit, class II needs dental treatment but is unlikely to require emergency dental treatment within the next twelve months, and class III is likely to turn into an emergency within twelve months and is thus targeted for priority treatment. All personnel not having seen a dentist for an examination for more than twelve months are assigned to class IV [79].

In 2008 Deutsch [19] presented data of 240 submarine patrols with 5,187 consultations, out of which only 3% were for dental conditions. A total of 67.3% of mariners were in class II and 26.5% were in class I. Of the dental consultations 22% were endodontic emergencies and only 2.8% were for third-molar-related emergencies, possibly due to an aggressive removal strategy prior to deployment. This converts to an emergency incidence rate of 5.0 per 100,000 person-days at sea. In contrast, we reported an emergency incidence rate of 48.3 per 100,000 person-days at sea for cruise-ship crews [58]. A meant time to dental emergencies for class 1 + 2 personnel of

418 days compared to 93 days in class 3 [54] testifies to screening and targeted dental treatment as effectively reducing dental emergencies at sea. However, even under near perfect conditions residual dental disease causes dental emergencies. Teweles [80] reported a figure of 33% of all emergencies as non-preventable, and Alexander [6] and Richardson [46] identified failing restorations as the most common cause for an unscheduled attendance. The US submarine force for the period 1991–1999 reported 90 requests by submarines for medical assistance due to dental conditions resulting in 70 evacuations, representing 8.2% of all evacuations [19].

In the merchant navy, International Labour Organisation/World Health Organisation (ILO/WHO) demands for “dental fitness” [81] are translated into national regulations. An example is the UK Merchant Shipping Notice 1765 (M) [82], which promulgates that a mariner is in fitness category 3 (temporarily unfit) if there is visual evidence of untreated dental defects or oral disease. A practical example would be a single missing front tooth, a clear case of a highly visible dental defect. In practice this condition would, in breach of the letter of the regulations, hardly lead to the refusal of a health certificate. NATO classification would acknowledge the defect by assigning it as class II, but as there is no risk of a dental emergency developing from this condition the mariner would be regarded as fit for duty. ILO/WHO demands lack detail, leading to a great diversity of national procedures regarding medical fitness. In the absence of professional dental input the assessment of dental and oral health is left to medical practitioners who have neither the equipment nor the expertise for a dental examination. Dahl [17] suggested that frequent dentist referrals in port were an indication that not all pre-boarding examinations were up to the expected standard. Therefore, during the revision and specification of ILO/WHO standards dental professional input should be considered to improve the quality of examinations. Standardised screening regimes and procedures should be developed and applied with independent monitoring of screening results. Klafstad [77] suggested radiographic orthopantomographic examinations and a mandatory dental certificate to be renewed at regular intervals, based on the results of a study of 450 individuals showing an accumulated need for surgical intervention in more than 50 % of cases. Intensive military screening systems with proven effectiveness [54] are a model that needs adaptation to suit civilian requirements. National regulations make exemptions for health certificates for



certain seafarers [82], which are hard to justify. Hahn [25] presented a cost comparison, arguing for the introduction of a certificate of dental health as a condition of employment in the offshore industry, a suggestion that might be worth considering in general seafaring as well, particularly for seafarers on long voyages [75].

As screening systems only identify treatment needs, they require mechanisms assuring delivery of treatment to correct relevant conditions. This raises the issue of accessibility and costs as relevant barriers [75] to the provision of dental care, which are barely considered in the literature. Chisick [12] suggests that individuals in poor oral health do not lack an understanding of their situation, but lists psychological (e.g. fear of dentist), structural (e.g. queues, proximity to care), and economic (e.g. unable to afford dental care) factors as potential barriers.

## DENTAL TREATMENT

Although ILO convention 164 [83] demands that all ships carrying 100 or more seafarers and ordinarily engaged in international voyages of more than three days' duration shall carry a medical doctor, there are no requirements for dental services, which, in the absence of a ship's doctor, are provided by ship's officers, like all medical services. Thus, the high proportion of papers reporting on the provision of dental care aboard does not reflect the reality of the situation. Only a small number of the largest vessels of some navies are equipped with permanent dental treatment facilities while in the military, mobile dental systems are somewhat more widespread [32, 33]. In port there are generally dedicated dental facilities available for military personnel, frequently with priority arrangements for seagoing crew. Ease of access and absence of cost as a barrier to dental treatment combined with regular compulsory screening examinations allows the military naval setting appear almost ideal in terms of dental care for seafarers.

Even though mobile dental services in the merchant navy have been proven to achieve substantial health gains for crew, civilian positions for dentists at sea are limited to rare Antarctic research expeditions and other exceptional, temporary positions. From the former eastern block one report describes 11,726 cases of dental treatment on board of vessels of the GDR in 1969 [84], and others report operations of mobile dental treatment units aboard merchant vessel of the Black Sea Shipping Company [34] achieving a sanitation ratio of 99.5% [24] in 1987. Voitenko [76] mentions 234 dentists employed to cover 40,000 sea-

farers around 1990, 26 of them working aboard, half with mobile clinics aboard merchant vessels, the other half aboard passenger ships. However, none of these reports consider cost issues and the level at which these services are currently operational is not known.

Merchant navy crews may or may not be covered for dental risk by the social security and healthcare systems of their home country. A survey published in 1995 covering 27 countries reported some financial support for dental treatment being available in 19 countries, depending on the treatment required, age, membership of an insurance scheme, etc. with funds originating from ship-owners (9/19), public insurance (11/19), or private insurance (4/19). Four countries reported dedicated oral health services for seafarers [75]. In the case of countries in which dental treatment at home is available and accessible, the limited periods of leave are often filled with numerous other obligations, so routine dental care may not be available fast enough [27] or may not have the highest priority [9]. While abroad, seafarers are generally covered by their employer for emergency treatment and pain control. For civilian seafarers with no dental facilities aboard, the percentage of dental causes for consultations in foreign ports can be as high as 66.9% [63]. Even in the case of the Black Sea Shipping Company, with their large number of seagoing dentists and high reported sanitation rate, dental problems still made up 42–48% of foreign port consultations [76]. In practice, due to communication barriers and time constraints in foreign ports, and not least due to the financial considerations of the employer, perfectly restorable teeth are extracted [75] as the quickest and easiest short-term solution [17, 28]. The lack of time [9] and absence of funding for conservative dentistry thus leads to early tooth loss with “one-visit” sanitation by extraction having been propagated where resources are limited [4]. The employer's responsibility generally ends with the end of the contract and seafarers are left to restore dentition at their own expense. To improve emergency dental care in port, port agents should be empowered to supply accurate information on emergency dental services for seafarers. Private/public partnerships could be developed to improve accessibility of dental services in ports [1, 72]. Mobile dental clinics offering emergency and routine dental treatment next to vessels while alongside have been used successfully by the military in large ports [26] to reduce barriers and have been suggested in the civilian sector [34]. Further research aimed at the interfaces between port health services, emplo-

yers, and health systems of home countries could help to identify financial and other barriers for routine and emergency dental treatment. Complex issues of funding oral health services for highly mobile clients in an environment with transnational stakeholders have to be explored. In the absence of dental officers aboard, recommendations for intensified ships' officers and doctors training carry weight. All components of an efficient delivery system of dental care for seafarers should be an integral part of their primary healthcare system [75].

### CRUISE SHIP DENTISTRY

In spite of the large numbers of crew and even larger numbers of passengers, cruise ships generally do not carry dentists. Occasionally, dental auxiliaries and a small number of dentists have been employed in the spa department limited to the provision of cosmetic dentistry, mainly dental bleaching. These departments are typically not equipped to provide general or emergency dental care. There are no publications covering these aspects of dental work at sea. It is known that a substantial proportion of work of cruise ship medical officers comprises of dental emergencies and incidents [16]. About one quarter of the civilian literature on oral health at sea deals with issues related to cruise ship dentistry with passengers and crews the focus of attention. The average cruise passenger is only aboard for one week [85], the average age being 46 years [86]. In this group removable prosthodontics associated with a higher rate of dental incidences are not an issue and dental emergencies are expected to be relatively rare. Short cruises have short sea-times and frequent port visits where, in case of dental emergencies, procedures are established to provide easy access to shoreside dental support.

Longer cruises are challenging, particularly world cruises with extended periods at sea sailing into remote areas with no shoreside dental facilities. On long cruises of more than three months' duration a mean age of passengers of 70 years has been reported. This higher age is associated with an increased rate of dental emergencies, which was calculated as 71.3 dental emergencies per 100,000 sea-days, in spite of 89% of the patients having seen a dentist within the last 12 months [59]. Complex prosthodontic needs in these privileged socioeconomic groups, which present with a growing number of implant-retained prosthesis, require skilled and experienced operators in case of complications. In remote locations these may be difficult to locate ashore.

A dental service aboard could contribute to the quality of life of passengers and crew alike on voyages of longer duration, on larger vessels, and when sailing to remote destinations. However, limited space aboard, cost of high-quality dental equipment and consumables, and the availability of skilled dentists are challenges faced by ships' operators.

### CONCLUSIONS

To improve the quantity and quality of data, health studies on seafarers should include oral-health components. Dental professional expertise should be sought in any policy development or revision of guidelines and regulations relevant to oral health. A clear strategy to improve the oral health of seafarers should be developed including: national oral disease prevention programs; efficient oral health screening systems followed by dental treatment confirmed by a certificate of dental health; and delivery systems of dental services for seafarers as integral part of their primary healthcare system. Aspects of military oral health care systems could be studied as an example for civilian operators. Funding strategies in a complex environment of transnational stakeholders for the improvement of oral-health services for seafarers are needed.

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### REFERENCES

1. 24-hour dental service for foreign seamen. J Can Dent Assoc 1979; 45 (6): 272.
2. A report on the design and development of the LHA-1 class general purpose amphibious assault ship medical/dental spaces. US Navy Med 1971; 57 (6): 13–19.
3. Aleksandrov VA. [Organization of dental care for sailors on a cruise]. Voen Med Zh 1982; (8): 43.
4. Aleksandrov VA. [Experience in rendering dental care to patients before and during a cruise]. Voen Med Zh 1987; (6): 51.
5. Aleksandrov NM, Chernysh VF. [Prevention of dental caries in a military unit (aboard ship)]. Voen Med Zh 1983; (10): 56–58.
6. Alexander DC. Dental recall status and unscheduled dental attendances in British warships. Mil Med 1996; 161 (5): 268–272.
7. Arendt DM. On duty: gator dentistry. US Navy Med 1978; 69 (6): 18–20.
8. Balin VN, Chernysh VF, Sosin VV. [The development of dental care in the Russian navy]. Voen Med Zh 1996; 317 (9): 58–60.
9. Bäter H. Dental Problems in Seafaring. In: Goethe WH (ed.). Handbook of nautical medicine, Berlin 1984.
10. Chesler M. Navy dentistry. Hawaii Dent J 2009; 40 (4): 6–7.



11. Chisick MC, Poindexter FR, York AK. Comparing dental utilization of United States of America military recruits with their employed civilian cohorts. *Clin Oral Investig* 1997; 1 (4): 195–198.
12. Chisick MC, Poindexter FR, York AK. Factors influencing perceived need for dental care by United States military recruits. *Clin Oral Investig* 1998; 2 (1): 47–51.
13. Courtois-Marchal C. [Dental surgery in the Royal Navy from the 18th century to the present]. *Inf Dent* 1987; 69 (32): 2779, 2781, 2783 passim.
14. Dahl E. Anatomy of a world cruise. *J Travel Med* 1999; 6 (3): 168–171.
15. Dahl E. Medical practice during a world cruise: a descriptive epidemiological study of injury and illness among passengers and crew. *Int Marit Health* 2005; 56 (1–4): 115–128.
16. Dahl E. Sick leave aboard – a one-year descriptive study among crew on a passenger ship. *Int Marit Health* 2005; 56 (1–4): 5–16.
17. Dahl E. Crew referrals to dentists and medical specialist ashore: a descriptive study of practice on three passenger vessels during one year. *Int Marit Health* 2006; 57 (1–4): 127–135.
18. Dantsig IN. [Dental caries and ultraviolet deficiency (based on observations on naval personnel)]. *Stomatologiya (Mosk)* 1974; 53 (1): 10–13.
19. Deutsch WM. Dental events during periods of isolation in the U.S. submarine force. *Mil Med* 2008; 173 (1 Suppl): 29–37.
20. Diefenderfer KE, Ahlf RL, Simecek JW, Levine ME. Periodontal health status in a cohort of young US Navy personnel. *J Public Health Dent* 2007; 67 (1): 49–54.
21. Elliott RW, JR. Organization of the Navy Dental Corps. *Int Dent J* 1975; 25 (4): 266–275.
22. Ellis FN. Dental appointment problems at sea. *US Armed Forces Med J* 1954; 5 (5): 721–723.
23. Goethe H, Rinck G, Gudmundsson G. [Diseases in the German deep sea fishing industry with reference to condition of dental bite.]. *Arch Gewerbepathol Gewerbehyg* 1959; 17 (1): 57–66.
24. Goranov B. [Results from the planned treatment of dental caries in sailors from Shipping Company BMF-Varna of a brigade base for the period 1978–1985]. *Stomatologiya (Sofiya)* 1987; 69 (4): 52–54.
25. Hahn MJ. The dental status of workers on offshore installations in the UK oil and gas industry. *Br Dent J* 1987; 163 (8): 262–264.
26. Hall FL. General practice organisation in the Royal Navy. *Br Dent J* 1972; 132 (8): 321–324.
27. Holttinen T, Murtomaa H, Saarni H, Pentti J, Alvesalo I. Utilization of dental services by Finnish seamen. *Acta Odontol Scand* 1994; 52 (2): 77–81.
28. Holttinen T, Saarni H, Murtomaa H, Pentti J, Alvesalo I. Seafaring: a risk for seamen's oral health? *Acta Odontol Scand* 1995; 53 (5): 275–278.
29. Hooley JR, Charboneau NF, Cunningham MS, Beane RA. Use of intravenous sedation for wisdom tooth surgery on aircraft carriers. *Mil Med* 1995; 160 (8): 398–400.
30. James PM. The relationship between gingivitis, dental caries experience, stature, intelligence and place of residence in 15-year-old boy entries to the Royal Navy; a pilot study. *J R Nav Med Serv* 1958; 44 (4): 266–271.
31. Johnson KA. A Portable Dental Surgery For Frigates And Other Small Ships. *J R Nav Med Serv* 1964; 50: 210–211.
32. Keeble GB, Rugg-Gunn AJ. Dental health of men in the Royal Navy 1978–80. *Br Dent J* 1983; 155 (10): 336–339.
33. Knox O. Battleship Texas – a floating city, dental office and all. *Tex Dent J* 1993; 110 (9): 19–21.
34. Kononenko LN, Pavlov NV, Shafran LM, Kurnosenko EV, Trudov Iu I. [New forms of the organization of stomatological aid to the ship's crew in the Black and Azov Sea basin]. *Sov Zdravookhr* 1974; 0 (5): 40–42.
35. Kukhtevich VG, Nianchuk BF. [Morbidity of caries in Soviet naval personnel on Danube ships]. *Stomatologiya (Mosk)* 1974; 53 (1): 84–85.
36. Langan LC. Caries experience of fifteen-year-old recruits joining the Royal Navy at HMS Ganges. *J R Nav Med Serv* 1969; 55 (3): 229–231.
37. Levy S. A survey of sea diseases on South African ships. *S Afr Med J* 1969; 43 (35): 1079–1082.
38. Liming JW. Medical-dental facilities in Navy ships and vibration hazards. *US Navy Med* 1972; 59 (1): 29–30.
39. Malejewska D, Fraczak B, Kubrak J et al. [Assessment of the condition of the stomatognathic system in the students of the High Navy School in Szczecin. 1. Study before one-year cruise]. *Protet Stomatol* 1990; 40 (1): 13–17.
40. Mausberg R, Hornecker E, Rellermeier I. Fallstudie zur Mundgesundheits auf einem Schiff der Bundesmarine. *Wehrmedizinische Monatsschrift* 2000; 44 (4): 65–70.
41. McGinley JL. U.S. Navy dental common access system emergency dental encounter module. *Mil Med* 2008; 173 (1 Suppl): 58.
42. McKay MP. Maritime health emergencies. *Occup Med (Lond)* 2007; 57 (6): 453–455.
43. Morgan MV, Stonnill A, Laslett AM. Dental caries amongst Royal Australian Navy recruits, 1988. *Aust Dent J* 1992; 37 (3): 201–204.
44. Naeve W. [Ship without a doctor. Diseases and injuries in the crew of a freighter on regular service between Europe and South America]. *Munch Med Wochenschr* 1971; 113 (24): 909–913.
45. Norman JN, Ballantine BN, Brebner JA, Brown B, Gauld SJ et al. Medical evacuations from offshore structures. *Br J Ind Med* 1988; 45 (9): 619–623.
46. Preventive dentistry in the US Navy: the three-agent program. *J Am Dent Assoc* 1971; 83 (5): 994–995.
47. Richardson PS. Dental morbidity in United Kingdom Armed Forces, Iraq 2003. *Mil Med* 2005; 170 (6): 536–541.
48. Rovelstad GH, Irons RP, Mc GJ, Hackman RC, Collevichio EJ. Survey of dental health of the naval recruit. I. Status of dental health. *J Am Dent Assoc* 1959; 58 (5): 60–68.
49. Saarni U, Saarni H. Xylitol for messrooms – a method worth trying to prevent caries among seafarers. *Bull Inst Marit Trop Med Gdynia* 1997; 48 (1–4): 91–97.
50. Sandbekk OW. [Seamen and dental health. Studies of tooth status among naval staff and merchant seamen. A review]. *Nor Tannlaegeforen Tid* 1977; 87 (7): 336–340.
51. Schaetzing G, Laban C, Goethe WH. The parodontium in seamen. *Bull Inst Marit Trop Med Gdynia* 1989; 40 (3–4): 193–200.

52. Schmidt L. [A naval dentist in the North Sea – report on experiences]. *Z Arztl Fortbild (Jena)* 1981; 75 (10): 483–489.
53. Schultz S. History of Navy dental care in Hawaii. *Hawaii Dent J* 2009; 40 (4): 5.
54. Simecek JW, McGinley JL, Levine ME, Diefenderfer KE, Ahlf RL. A statistical method to evaluate dental classification systems used by military dental services. *Mil Med* 2008; 173 (1 Suppl): 51–55.
55. Singh A. Oral health knowledge, attitude and practice among NCC Navy Cadets and their correlation with oral hygiene in south India. *Oral Health Prev Dent* 2009; 7 (4): 363–367.
56. Slepchenko MA. [Means for further improvement of dental care in the Army and Navy]. *Voen Med Zh* 1988; (4): 3–5.
57. Sobotta BA, John MT, Nitschke I. Dental practice during a world cruise: characterisation of oral health at sea. *Int Marit Health* 2006; 57 (1–4): 136–148.
58. Sobotta BA, John MT, Nitschke I. Dental practice during a world cruise: treatment needs and demands of crew. *Int Marit Health* 2007; 58 (1–4): 59–69.
59. Sobotta BA, John MT, Nitschke I. Cruise medicine: the dental perspective on health care for passengers during a world cruise. *J Travel Med* 2008; 15 (1): 19–24.
60. Starkey WE. Improved dental status in 15-year-old candidates for the Royal Navy 1957–59 survey compared with 1963–65. *Br Dent J* 1966; 121 (10): 457–460.
61. The Navy Dental Corps: quality dental care in peacetime. *US Navy Med* 1975; 66 (2): 4–5.
62. Tomaszunas S. A review of health problems of seafarers. *Biul Inst Med Morsk Gdansk* 1974; 25 (1): 103–111.
63. Tomaszunas S. The work of ship's doctors of Polish Ocean Lines. *Bull Inst Marit Trop Med Gdynia* 1985; 36 (1–4): 51–58.
64. Tomaszunas S, Weclawik Z, Lewinski M. Morbidity, injuries and sick absence in fishermen and seafarers – a prospective study. *Bull Inst Marit Trop Med Gdynia* 1988; 39 (3–4): 125–135.
65. Trunov Iu I, Murav'ev VI. [Fluorine content in the drinking water on board ships and the caries morbidity of cruise personnel]. *Gig Sanit* 1975; (2): 114–115.
66. Ugulava SN. [Experience in the organization of dental health education in the navy]. *Voen Med Zh* 1965; 12: 62–63.
67. Urner CJ. SHIP: the Seafarers Health Improvement Program. *J Occup Med* 1987; 29 (6): 531–534.
68. Verney K. Dentistry in Nelson's time. *J R Nav Med Serv* 2005; 91 (2): 96–98.
69. Weiss M. Standards on medical fitness examinations for Navy divers. *Int Marit Health* 2003; 54 (1–4): 135–143.
70. Werner R. [Peculiarities of dental practice on ships.]. *Dtsch Zahnarztl Z* 1955; 10 (9): 661–663.
71. Weyers H. [Dental problems and a ship's doctor's resources]. *Dtsch Schwesternztg* 1967; 20 (10): 466–471.
72. Wianz E. Die zahnärztliche Versorgung von Seeleuten der deutschen Hochseefischerei. *Dtsch. zahnärztl. Z.* 1982; 37: 391–396.
73. Woodman AJ. The influence of periodontal screening upon dental hygienist practice in the Royal Navy. *J R Nav Med Serv* 1988; 74 (3): 165–171.
74. Young JL. Medical-dental activation of ships. *Med Techn Bull* 1951; 2 (4): 191–197.
75. Saarni U-M, Saarni H, Holttinen T, Fellman MT. Seafarer's dental health – an international problem? In: Third international symposium on maritime health; 1995; Baltimore, M.D.: Maritime institute of technology and graduate studies; 1997; 139–142.
76. Voitenko AM, N VG, Kurnosenko EV. Organization of dental care for the Black Sea Shipping Company (BLASCO). In: The international symposium on maritime health; 1991. Regional Institute of Occupational Health, Turku 1991; 256–258.
77. Klafstad J. Dental morbidity in Norwegian seafarers with special reference to surgical odontopathology. In: The fourth international symposium on maritime health. The Norwegian association for maritime medicine; The Norwegian maritime directorate, Oslo 1997; 36.
78. Phillips B, Ball C, Sacket D et al. Oxford Centre for Evidence-based Medicine – Levels of Evidence. 2009 [cited; Available from: <http://www.cebm.net/index.aspx?o=1025>].
79. Richardson PS. Dental Risk Assessment for Military Personnel. 2005 [cited 02.01.2011]; Available from: [http://findarticles.com/p/articles/mi\\_qa3912/is\\_200506/ai\\_n13644584/?tag=content:col1](http://findarticles.com/p/articles/mi_qa3912/is_200506/ai_n13644584/?tag=content:col1).
80. Teweles RB, King JE. Impact of troop dental health on combat readiness. *Mil Med* 1987; 152 (5): 233–235.
81. ILO/WHO. Guidelines for Conducting Pre-sea and Periodic Medical Fitness Examinations for Seafarers. 1997 [cited 02.01.2011]; Available from: <http://www.ilo.org/public/english/dialogue/sector/techmeet/ilowho97/index.htm>.
82. MCA. Seafarer Medical Examination System and Medical and Eyesight Standards. 2002 [cited 02.01.2011]; Available from: <http://www.pml-solas.org.uk/forms/msn1765.pdf>.
83. ILO. Health Protection and Medical Care (Seafarers) Convention, (No. 164). 1987 [cited 12.01.2011]. Available from: <http://webfusion.ilo.org/public/db/standards/normes/appl/appl-displayConv.cfm?conv=C164&hdroff=1&lang=en>.
84. Bormann H. Entwicklung, Aufgaben und Bedeutung der stomatologischen Betreuung. In: Medizinischer Dienst des Verkehrswesens der DDR. Rostock; 1969.
85. Scull TW. 2004 Yearend Review. *Cruise Travel* 2005; (February).
86. CLIA. Profile of the US Cruise Industry. 2010 [cited 02.01.2011]. Available from: <http://www.cruising.org/pressroom-research/cruise-industry-source-book/profile-us-cruise-industry>.